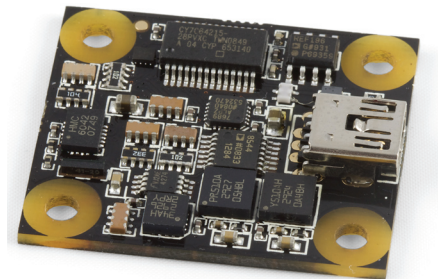
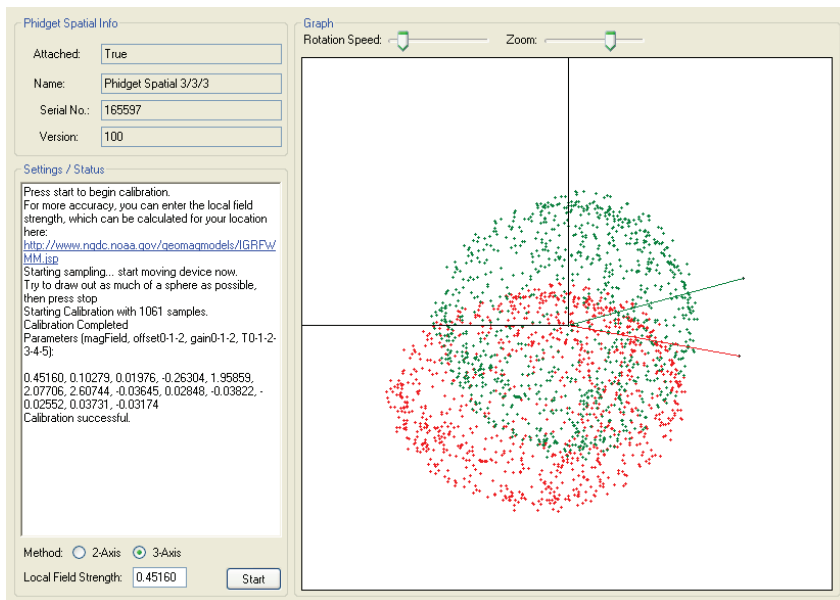




Application Note

Using the Compass Calibrator

1056 - PhidgetSpatial 3/3/3



Using the Compass Calibrator

Compasses can be found in a multitude of applications, including navigation, remotely operated vehicles (ROVs), and motion sensing. When operating away from other devices, it is only the Earth's magnetic field that acts on the compass.

Why do you have to Calibrate?

In most applications, compasses are rarely used by themselves, away from devices that generate their own magnetic field, and surrounding metal that can distort the magnetic field. Iron and steel will often have some degree of magnetism, and if in the vicinity of the compass, can easily produce fields stronger than the Earth's magnetic field. They will also distort and channel the earth's magnetic field. Electromagnetic fields produced by the flow of current will often be detected by the compass as well. Motors and solenoids will produce very concentrated magnetic fields, but even current flowing through wiring will produce fields.

A 3-Axis Solid State Compass like the 1056 does not measure the magnetic field of the earth - it measures the prevailing magnetic field it is in. If the compass is in a special magnetic shielding box, no field will be measured. If a strong magnet is placed next to the compass, it will measure the field from the magnet and the Earth's magnetic field added together. A mechanical compass will measure the same field, and is no more immune than the solid state compass.

What can be calibrated out, and what cannot?

Software allows sophisticated calibration techniques for some sources of interference. Many sources of interference that are fixed with respect to the compass can be calibrated out. For instance, if a compass is mounted inside a car, the magnetic fields of the car, and the effect it has on the Earth's magnetic field can be calibrated out, assuming the interfering fields are not too strong. You cannot calibrate out the effect of other cars in the environment, as they are not in a fixed location.

If you have a small robot travelling around on a concrete floor, the metal structure of the robot can be calibrated out, but the rebar in the floor cannot. The effect of the electrical drive motors cannot be calibrated out, as it won't be consistent.

Basic Operation of the Compass Calibrator

There are two methods that the Compass Calibrator uses to calibrate the compass: 2-axis and 3-axis. The 2-axis method requires one full rotation in the xy-plane to draw out a circle. This method is less accurate, but still does quite well as long as the 1056 stays fairly close to level. The 3-axis method draws out a sphere using the data from all three axes. The more the sphere is drawn out, the better the accuracy. A good example of where 2-axis calibration must be used is in a car, where it may not be practical to rotate the car in 3 axis.

The Compass Calibrator program takes in samples of each axis of the compass. Once the sampling period is finished, the calibration algorithm is applied and returns thirteen values. These values represent phenomena such as local magnetic field, axis gains, axis offsets, and other parameters to factor out hard and soft iron offsets in the application.

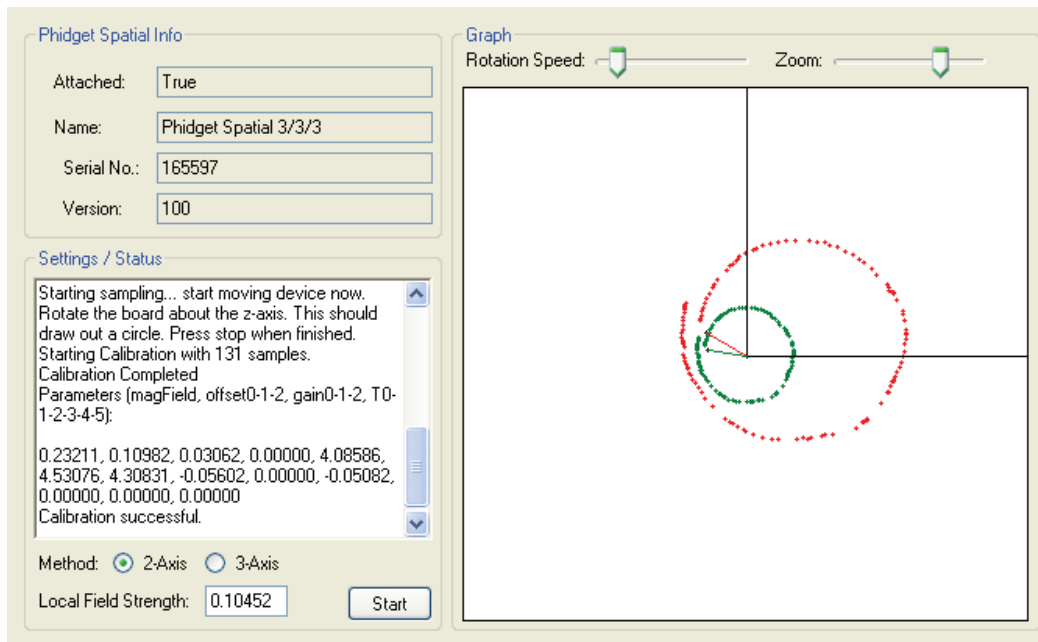
Proper Use and Set-up

To properly and accurately calibrate the compass, the compass needs to be secured in the application. It is also important that the application be running as expected (or as closely as possible) during normal operation. This includes having the motors running constantly, etc, but also avoiding any sudden changes in magnetic fields, such as motors drastically changing speeds, or solenoids activating and deactivating.

When the calibration program is run, the compass and application need to be rotated as required by the calibration method. Only one full rotation is required for the 2-axis method, keeping the application as level as possible. The 3-axis method can be rotated arbitrarily, and requires as much of the sphere to be drawn out as possible in order to achieve a higher degree of accuracy.

During the data acquisition period, the red dots on the graph represent the direction of the magnetic field relative to the compass. Once the sampling period is over, the calibration program will display thirteen parameters. When these parameters are applied to the sampled data (the red points on the graph), the resulting data (green data points) will outline a circle, or a sphere, centered on the origin. This gives a graphical representation of how the calibration output parameters shift and transform the error-filled sampled data into a close approximation of either a circle or sphere. This can be used to visually validate the accuracy of the calibration.

2D Calibration



3D Calibration

Phidget Spatial Info

Attached: True

Name:

Serial No.:

Version:

Settings / Status

Press start to begin calibration.
For more accuracy, you can enter the local field strength, which can be calculated for your location here:
<http://www.ngdc.noaa.gov/geomagmodels/IGRFwMM.jsp>
Starting sampling... start moving device now.
Try to draw out as much of a sphere as possible, then press stop
Starting Calibration with 1061 samples.
Calibration Completed
Parameters (magField, offset0-1-2, gain0-1-2, T0-1-2, 3-4-5):
0.45160, 0.10279, 0.01976, -0.26304, 1.95859,
2.07706, 2.60744, -0.03645, 0.02848, -0.03822, -
0.02552, 0.03731, -0.03174
Calibration successful.

Method: 2-Axis 3-Axis

Local Field Strength:

Graph
Rotation Speed: Zoom:

To finalize the calibration and use the results in your software application, use the resulting parameter data as input parameters to the `setCompassCorrectionParameters` method, in the appropriate language. This can be done once the 1056 - PhidgetSpatial 3/3/3 is attached.